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(54) FACILITATING INVERSE MULTIPLEXING OVER ASYNCHRONOUS TRANSFER MODE VIA COMMUNICATION LINKS HAVING DISPARATE DATA TRANSIMISSION RATES

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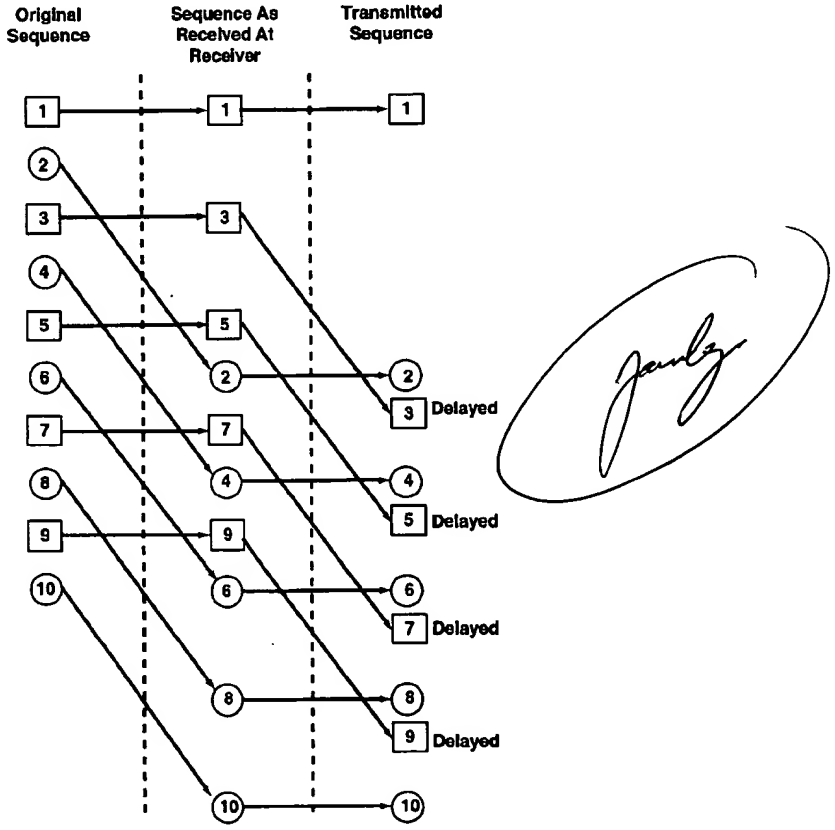
(57) ABSTRACT

A method for facilitating inverse multiplexing over asynchronous transfer mode is disclosed herein. The method includes receiving a stream of sequentially aligned ATM cells via an originating end point logical communication link. A sequence identifier is associated with each one of the ATM cells for creating sequence-identified ATM cells. The sequence-identified ATM cells are forwarded to a destination endpoint logical communication link in a distributed manner over a plurality of IM communication links. A first one of said IM communication links has disparate data transmission rates in at least one data transmission direction with respect to a second one of the IM communication links.



for data communication links, such as ADSL communication links, to not synchronize at the same upstream and/or downstream data transmission rate. Accordingly, the inverse multiplexing techniques disclosed herein provide significant advantages relative to the conventional inverse multiplexing techniques.

[0075] Utilizing the IMA techniques disclosed herein, a first ADSL communication link is combined with one or more additional ADSL communication links that have disparate upstream and/or downstream data transmission rates relative to the first ADSL communication link. The result is a group of physically lower speed ADSL communication links that behave identically to a single point-to-point high-speed communication link of the same capacity as the group of lower speed ADSL communication links. In this manner, increased data transmission rates can be achieved when cost or technical feasibility prevents deployment of a single high-speed point-to-point communication link. It is contemplated that the methods, systems and apparatuses disclosed herein may be useful with data communication links that have disparate data transmission rates, other than ADSL communication links.

[0076] The transient behavior of the links during times of link speed changes is simplified because the sequence number provides a reliable method to accurately reorder cells that is independent of links speed and delay. Under the new approach, if the bit rate of any one of the links in a group must be decreased or increased, the change may be performed independently of the other links and without disruption of service to the subscriber. The new approach is not constrained by changing bit rates of individual links within a bonded group as member links may operate at their optimal speed regardless of the instantaneous speed of the other links. Accordingly, the complexity of establishing a bonded group is reduced because there is no longer a requirement to measure differential link speed or to confirm that links are operating at precisely the same bit rate.

[0077] Furthermore, the new approach is not restricted by differential delay between members of the group, other than by the depth of the buffers that have been implemented at the transmitter and receiver ends. It is preferred to try to minimize the delay across any one link. However, the receiver buffer may be sized to accommodate any differential delay. In this manner, adverse affects associated with differential delay are reduced.

[0078] In the preceding detailed description, reference has been made to the accompanying drawings that form a part hereof, and in which are shown by way of illustration specific embodiments in which the invention may be practiced. These embodiments, and certain variants thereof, have been described in sufficient detail to enable those skilled in the art to practice the invention. It is to be understood that other suitable embodiments may be utilized and that logical, mechanical, chemical and electrical changes may be made without departing from the spirit or scope of the invention. For example, functional blocks shown in the figures could be further combined or divided in many manners without departing from the spirit or scope of the invention. To avoid unnecessary detail, the description omits certain information known to those skilled in the art. The preceding detailed description is, therefore, not intended to be limited to the specific forms set forth herein, but on the contrary, it is intended to cover such alternatives, modifications, and equivalents, as can be reasonably included within the spirit and scope of the appended claims.

What is claimed is:

1. A method for facilitating inverse multiplexing over asynchronous transfer mode, comprising:

receiving a stream of sequentially aligned ATM cells via an originating end point logical communication link;

associating a sequence identifier with each one of said ATM cells for creating sequence-identified ATM cells;

holding a first portion and a second portion of said sequence-identified ATM cells in a first transmitter queue and a second transmitter queue, respectively, wherein the first transmitter queue and the second transmitter queue are associated with a first one and a second one, respectively, of a plurality of IM communication links; and

sequentially forwarding said sequence-identified ATM cells from each said queue over said associated one of the plurality of IM communication links, wherein the first one of the plurality of IM communication links has a data transmission rate disparate in at least one data transmission direction with respect to a data transmission rate of the second one of the plurality of IM communication links.

2. The method of claim 1 wherein:

receiving the stream of sequentially aligned ATM cells includes receiving the stream of sequentially aligned ATM cells at a transmitter queue selector; and

the transmitter queue selector is capable of enabling the first portion and the second portion of said sequence-identified ATM cells to be added to the first transmitter queue and the second transmitter queue, respectively.

3. The method of claim 1 wherein associating the sequence identifier with each one of said ATM cells includes determining a sequence code for each one of said ATM cells and inserting the sequence code for each one of said ATM cells into an information payload portion of a corresponding one of said ATM cells.

4. The method of claim 1 wherein associating the sequence identifier with each one of said ATM cells includes determining a sequence code for each one of said ATM cells and inserting the sequence code for each one of said ATM cells into a header portion of a corresponding one of said ATM cells.

5. The method of claim 4 wherein associating the sequence identifier with each one of said ATM cells includes identifying at least one of unused addressing bits and unused address space within the header portion of the corresponding one of said ATM cells and redefining said at least one of unused addressing bits and unused address space to designate the sequence identifier.

6. The method of claim 4 wherein:

associating the sequence identifier with each one of said ATM cells includes identifying when a particular sequence identifier results in a header portion bit value that corresponds to a reference bit value designating a reference function.

7. The method of claim 6, further comprising:

preventing the particular sequence identifier from being associated with any one of said ATM cells.

8. The method of claim 1 wherein associating the sequence identifier with each one of said ATM cells includes determining the sequence identifier for each one of said ATM cells in response to each one of said ATM cells arriving at a transmitter queue selector.

9. The method of claim 1, further comprising:

specifying a cell capacity of the first transmitter queue and a cell capacity of the second transmitter queue, wherein the cell capacity of the first transmitter queue and the cell capacity of the second transmitter queue are based on a reference data transmission rate of the first one of the plurality of IM communication links and to a reference data transmission rate of the second one of the plurality of IM communication links, respectively.

10. The method of claim 9 wherein:

the cell capacity of the first queue and the cell capacity of the second queue are different; and

an approximately common time period is required for transmitting a number of cells equal to the cell capacity of the first queue and a number of cells equal to the cell capacity of the second queue across the first one of the plurality of IM communication links and the second one of the plurality of IM communication links, respectively.

11. The method of claim 10 wherein holding the first portion and the second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, includes directing a next one of the sequence-identified ATM cells to a most empty one of the first transmitter queue and the second transmitter queue.

12. The method of claim 11 wherein holding the first portion and the second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, includes directing a previous one of the sequence-identified ATM cells to one of the first transmitter queue and the second transmitter queue and directing the next one of the sequence-identified ATM cells to a next transmitter queue with respect to said one of the first transmitter queue and the second transmitter queue.

13. The method of claim 1 wherein forwarding said sequence-identified ATM cells in a distributed manner over a plurality IM communication links includes forwarding said sequence-identified cells over a plurality of IM-ADSL communication links.

14. The method of claim 13 wherein:

a first one of said IM-ADSL communication links is synchronized at a first upstream data transmission rate; and

a second one of said IM-ADSL communication links is synchronized at a second upstream data transmission rate different than the first upstream data transmission rate.

15. The method of claim 13 wherein:

a first one of said IM-ADSL communication links is synchronized at a first downstream data transmission rate; and

a second one of said IM-ADSL communication links is synchronized at a second downstream data transmission rate different than the first downstream data transmission rate.

16. The method of claim 13 wherein:

a first one of said IM-ADSL communication links is synchronized at a first downstream data transmission rate and at a first upstream data transmission rate; and

a second one of said IM-ADSL communication links is synchronized at a second downstream data transmission rate different than the first downstream data transmission rate and at a second upstream data transmission rate different than the first upstream data transmission rate.

17. The method of claim 1, further comprising:

receiving at least a portion of said sequence-identified ATM cells; and

forwarding an aligned stream of inversely multiplexed ATM cells from the receiver across a destination endpoint logical communication link.

18. The method of claim 17 wherein receiving said sequence-identified ATM cells includes holding at least a portion of said sequence-identified ATM cells in a receiver queue.

19. The method of claim 18, further comprising:

determining a receiver queue position associated with each one of said sequence-identified ATM cells in response to receiving each one of said sequence-identified ATM cells.

20. The method of claim 18 wherein forwarding the aligned stream of inversely multiplexed ATM cells includes sequentially retrieving said sequence-identified ATM cells from the receiver queue.

21. The method of claim 19 wherein sequentially retrieving said sequence-identified ATM cells includes identifying a next one of said sequence-identified ATM cells to forward.

22. The method of claim 21 wherein identifying the next one of the sequence-identified ATM cells includes determining the sequence identifier associated with the next one of the sequence-identified ATM cell.

23. The method of claim 19 wherein sequentially retrieving said sequence-identified ATM cells includes:

delaying forwarding of a received one of said sequence-identified ATM cells being held in the receiver queue in response to determining that the next one of said sequence-identified ATM cells is missing from an expected position in the receiver queue;

discontinuing attempts to retrieve the next one of said sequence-identified ATM cells after a prescribed time period elapses while the next one of said sequence-identified ATM cells remains missing from the expected positioning the receiver queue; and

retrieving the next one of said sequence-identified ATM cells before the prescribed time period elapses in response to determining that the next one of said sequence-identified ATM cells is located in the expected position in the receiver queue after having initially determined that the next one of said sequence-identified ATM cells was missing from an expected position in the receiver queue.

24. The method of claim 23 wherein forwarding the aligned stream of inversely multiplexed ATM cells from the receiver includes:

forwarding the received one of said sequence-identified ATM cells after the prescribed time period elapses in response to the next one of said sequence-identified ATM cells remains missing from the expected positioning the receiver queue after the prescribed time period elapses; and

forwarding the next one of said sequence-identified ATM cells in response to retrieving the next one of said sequence-identified ATM cells before the prescribed time period elapses and after having initially determined that the next one of said sequence-identified ATM cells was missing from an expected position in the receiver queue.

25. A method for facilitating inverse multiplexing over asynchronous transfer mode, comprising:

receiving a stream of sequentially aligned ATM cells via an originating end point logical communication link, wherein the stream of sequentially aligned ATM cells is received at a transmitter queue selector and the transmitter queue selector is capable of enabling the first portion and the second portion of said sequence-identified ATM cells to be added to the first transmitter queue and the second transmitter queue, respectively;

associating a sequence identifier with each one of said ATM cells for creating sequence-identified ATM cells, wherein associating the sequence identifier with each one of said ATM cells includes identifying when a particular sequence identifier results in a header portion bit value that corresponds to a reference bit value designating a reference function and preventing the particular sequence identifier from being associated with any one of said ATM cells;

specifying a cell capacity of a first transmitter queue and a cell capacity of a second transmitter queue, wherein the cell capacity of the first transmitter queue and the cell capacity of the second transmitter queue are based on a reference data transmission rate of the first one of the plurality of IM communication links and to a reference data transmission rate of the second one of the plurality of IM communication links, respectively;

holding a first portion and a second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, wherein the first transmitter queue and the second transmitter queue are associated with a first one and a second one, respectively, of a plurality of IM communication links;

sequentially forwarding said sequence-identified ATM cells from each said queue over said associated one of the plurality of IM communication links, wherein the first one of the plurality of IM communication links has a data transmission rate disparate in at least one data transmission direction with respect to a data transmission rate of the second one of the plurality of IM communication links;

receiving at least a portion of said sequence-identified ATM cells by a receiver;

determining a receiver queue position associated with each one of said sequence-identified ATM cells in response to receiving each one of said sequence-identified ATM cells; and

forwarding an aligned stream of inversely multiplexed ATM cells from the receiver across a destination endpoint logical communication link.

26. The method of claim 25 wherein associating the sequence identifier with each one of said ATM cells includes determining a sequence code for each one of said ATM cells and inserting the sequence code for each one of said ATM cells into a header portion of a corresponding one of said ATM cells.

27. The method of claim 26 wherein associating the sequence identifier with each one of said ATM cells includes identifying at least one of unused addressing bits and unused address space within the header portion of the corresponding one of said ATM cells and redefining said at least one of unused addressing bits and unused address space to designate the sequence identifier.

28. The method of claim 25 wherein associating the sequence identifier with each one of said ATM cells includes determining the sequence identifier for each one of said ATM cells in response to each one of said ATM cells arriving at a transmitter queue selector.

29. The method of claim 25 wherein:

the cell capacity of the first queue and the cell capacity of the second queue are different; and

an approximately common time period is required for transmitting a number of cells equal to the cell capacity of the first queue and a number of cells equal to the cell capacity of the second queue across the first one of the plurality of IM communication links and the second one of the plurality of IM communication links, respectively.

30. The method of claim 29 wherein holding the first portion and the second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, includes directing a next one of the sequence-identified ATM cells to a most empty one of the first transmitter queue and the second transmitter queue.

31. The method of claim 30 wherein holding the first portion and the second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, includes directing a previous one of the sequence-identified ATM cells to one of the first transmitter queue and the second transmitter queue and directing the next one of the sequence-identified ATM cells to a next transmitter queue with respect to said one of the first transmitter queue and the second transmitter queue.

32. The method of claim 25 wherein receiving said sequence-identified ATM cells includes holding at least a portion of said sequence-identified ATM cells in a receiver queue.

33. The method of claim 25 wherein forwarding the aligned stream of inversely multiplexed ATM cells includes sequentially retrieving said sequence-identified ATM cells from the receiver queue.

34. The method of claim 33 wherein sequentially retrieving said sequence-identified ATM cells includes identifying a next one of said sequence-identified ATM cells to forward.

35. The method of claim 34 wherein identifying the next one of the sequence-identified ATM cells includes determin-

ing the sequence identifier associated with the next one of the sequence-identified ATM cell.

36. The method of claim 33 wherein sequentially retrieving said sequence-identified ATM cells includes:

delaying forwarding of a received one of said sequence-identified ATM cells being held in the receiver queue in response to determining that the next one of said sequence-identified ATM cells is missing from an expected position in the receiver queue;

discontinuing attempts to retrieve the next one of said sequence-identified ATM cells after a prescribed time period elapses while the next one of said sequence-identified ATM cells remains missing from the expected positioning the receiver queue; and

retrieving the next one of said sequence-identified ATM cells before the prescribed time period elapses in response to determining that the next one of said sequence-identified ATM cells is located in the expected position in the receiver queue after having initially determined that the next one of said sequence-identified ATM cells was missing from an expected position in the receiver queue.

37. The method of claim 36 wherein forwarding the aligned stream of inversely multiplexed ATM cells from the receiver includes:

forwarding the received one of said sequence-identified ATM cells after the prescribed time period elapses in response to the next one of said sequence-identified ATM cells remains missing from the expected positioning the receiver queue after the prescribed time period elapses; and

forwarding the next one of said sequence-identified ATM cells in response to retrieving the next one of said sequence-identified ATM cells before the prescribed time period elapses and after having initially determined that the next one of said sequence-identified ATM cells was missing from an expected position in the receiver queue.

38. A data processor program product, comprising:

a first data processor program processable by a first data processor;

a first apparatus from which the first data processor program is accessible by the first data processor; and

the first data processor program being capable of enabling the first data processor to facilitate:

receiving a stream of sequentially aligned ATM cells via an originating end point logical communication link;

associating a sequence identifier with each one of said ATM cells for creating sequence-identified ATM cells;

holding a first portion and a second portion of said sequence-identified ATM cells in a first transmitter queue and a second transmitter queue, respectively, wherein the first transmitter queue and the second transmitter queue are associated with a first one and a second one, respectively, of a plurality of IM communication links; and

sequentially forwarding said sequence-identified ATM cells from each said queue over said associated one of the plurality of IM communication links, wherein the first one of the plurality of IM communication links has a data transmission rate disparate in at least one data transmission direction with respect to a data transmission rate of the second one of the plurality of IM communication links.

39. The data processor program product of claim 38 wherein:

enabling the first data processor to facilitate receiving the stream of sequentially aligned ATM cells includes enabling the first data processor to facilitate receiving the stream of sequentially aligned ATM cells at a transmitter queue selector; and

the transmitter queue selector is capable of enabling the first portion and the second portion of said sequence-identified ATM cells to be added to the first transmitter queue and the second transmitter queue, respectively.

40. The data processor program product of claim 38 wherein enabling the first data processor to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first data processor to facilitate determining a sequence code for each one of said ATM cells and to facilitate inserting the sequence code for each one of said ATM cells into an information payload portion of a corresponding one of said ATM cells.

41. The data processor program product of claim 38 wherein enabling the first data processor to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first data processor to facilitate determining a sequence code for each one of said ATM cells and to facilitate inserting the sequence code for each one of said ATM cells into a header portion of a corresponding one of said ATM cells.

42. The data processor program product of claim 41 wherein enabling the first data processor to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first data processor to facilitate identifying at least one of unused addressing bits and unused address space within the header portion of the corresponding one of said ATM cells and to facilitate redefining said at least one of unused addressing bits and unused address space to designate the sequence identifier.

43. The data processor program product of claim 41 wherein enabling the first data processor to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first data processor to facilitate identifying when a particular sequence identifier results in a header portion bit value that corresponds to a reference bit value designating a reference function.

44. The data processor program product of claim 43 wherein the first data processor program is further capable of enabling the first data processor to facilitate:

preventing the particular sequence identifier from being associated with any one of said ATM cells.

45. The data processor program product of claim 38 wherein enabling the first data processor to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first data processor to facilitate determining the sequence identifier for each one of said ATM cells in response to each one of said ATM cells arriving at a transmitter queue selector.

46. The data processor program product of claim 38 wherein the first data processor program is further capable of enabling the first data processor to facilitate:

specifying a cell capacity of the first transmitter queue and a cell capacity of the second transmitter queue, wherein the cell capacity of the first transmitter queue and the cell capacity of the second transmitter queue are based on a reference data transmission rate of the first one of the plurality of IM communication links and to a reference data transmission rate of the second one of the plurality of IM communication links, respectively.

47. The data processor program product of claim 46 wherein:

the cell capacity of the first queue and the cell capacity of the second queue are different; and

an approximately common time period is required for transmitting a number of cells equal to the cell capacity of the first queue and a number of cells equal to the cell capacity of the second queue across the first one of the plurality of IM communication links and the second one of the plurality of IM communication links, respectively.

48. The data processor program product of claim 47 wherein enabling the first data processor to facilitate holding the first portion and the second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, includes enabling the first data processor to facilitate directing a next one of the sequence-identified ATM cells to a most empty one of the first transmitter queue and the second transmitter queue.

49. The data processor program product of claim 48 wherein enabling the first data processor to facilitate holding the first portion and the second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, includes enabling the first data processor to facilitate directing a previous one of the sequence-identified ATM cells to one of the first transmitter queue and the second transmitter queue and directing the next one of the sequence-identified ATM cells to a next transmitter queue with respect to said one of the first transmitter queue and the second transmitter queue.

50. The data processor program product of claim 38 wherein enabling the first data processor to facilitate forwarding said sequence-identified ATM cells in a distributed manner over a plurality IM communication links includes enabling the first data processor includes forwarding said sequence-identified cells over a plurality of IM-ADSL communication links.

51. The data processor program product of claim 50 wherein:

a first one of said IM-ADSL communication links is synchronized at a first upstream data transmission rate; and

a second one of said IM-ADSL communication links is synchronized at a second upstream data transmission rate different than the first upstream data transmission rate.

52. The data processor program product of claim 50 wherein:

a first one of said IM-ADSL communication links is synchronized at a first downstream data transmission rate; and

a second one of said IM-ADSL communication links is synchronized at a second downstream data transmission rate different than the first downstream data transmission rate.

53. The data processor program product of claim 50 wherein:

a first one of said IM-ADSL communication links is synchronized at a first downstream data transmission rate and at a first upstream data transmission rate; and

a second one of said IM-ADSL communication links is synchronized at a second downstream data transmission rate different than the first downstream data transmission rate and at a second upstream data transmission rate different than the first upstream data transmission rate.

54. The data processor program product of claim 38, further comprising:

a second data processor program processable by a second data processor;

a second apparatus from which the second data processor program is accessible by the second data processor; and

the second data processor program being capable of enabling the second data processor to facilitate:

receiving at least a portion of said sequence-identified ATM cells; and

forwarding an aligned stream of inversely multiplexed ATM cells from the receiver across a destination endpoint logical communication link.

55. The data processor program product of claim 54 wherein enabling the second data processor to facilitate receiving said sequence-identified ATM cells includes enabling the second data processor to facilitate holding at least a portion of said sequence-identified ATM cells in a receiver queue.

56. The data processor program product of claim 55 wherein the second data processor program is further capable of enabling the second data processor to facilitate:

determining a receiver queue position associated with each one of said sequence-identified ATM cells in response to receiving each one of said sequence-identified ATM cells.

57. The data processor program product of claim 55 wherein enabling the data processor to facilitate forwarding the aligned stream of inversely multiplexed ATM cells includes enabling the second data processor to facilitate sequentially retrieving said sequence-identified ATM cells from the receiver queue.

58. The data processor program product of claim 57 wherein enabling the second data processor to facilitate sequentially retrieving said sequence-identified ATM cells includes enabling the second data processor to facilitate identifying a next one of said sequence-identified ATM cells to forward.

59. The data processor program product of claim 58 wherein enabling the second data processor to facilitate identifying the next one of the sequence-identified ATM cells includes enabling the second data processor to facilitate determining the sequence identifier associated with the next one of the sequence-identified ATM cell.

60. The data processor program product of claim 56 wherein enabling the second data processor to facilitate sequentially retrieving said sequence-identified ATM cells includes enabling the second data processor to facilitate:

delaying forwarding of a received one of said sequence-identified ATM cells being held in the receiver queue in response to determining that the next one of said sequence-identified ATM cells is missing from an expected position in the receiver queue;

discontinuing attempts to retrieve the next one of said sequence-identified ATM cells after a prescribed time period elapses while the next one of said sequence-identified ATM cells remains missing from the expected positioning the receiver queue; and

retrieving the next one of said sequence-identified ATM cells before the prescribed time period elapses in response to determining that the next one of said sequence-identified ATM cells is located in the expected position in the receiver queue after having initially determined that the next one of said sequence-identified ATM cells was missing from an expected position in the receiver queue.

61. The data processor program product of claim 60 wherein enabling the second data processor to facilitate forwarding the aligned stream of inversely multiplexed ATM cells from the receiver includes enabling the second data processor to facilitate:

forwarding the received one of said sequence-identified ATM cells after the prescribed time period elapses in response to the next one of said sequence-identified ATM cells remains missing from the expected positioning the receiver queue after the prescribed time period elapses; and

forwarding the next one of said sequence-identified ATM cells in response to retrieving the next one of said sequence-identified ATM cells before the prescribed time period elapses and after having initially determined that the next one of said sequence-identified ATM cells was missing from an expected position in the receiver queue.

62. A data processor program product, comprising:

a first data processor program processable by a first data processor;

a second data processor program processable by a second data processor

a first apparatus from which the first data processor program is accessible by the first data processor;

a second apparatus from which the second data processor program is accessible by the second data processor;

the first data processor program being capable of enabling the first data processor to facilitate:

receiving a stream of sequentially aligned ATM cells via an originating end point logical communication link, wherein the stream of sequentially aligned ATM cells is received at a transmitter queue selector and the transmitter queue selector is capable of enabling the first portion and the second portion of said sequence-identified ATM cells to be added to the first transmitter queue and the second transmitter queue, respectively;

associating a sequence identifier with each one of said ATM cells for creating sequence-identified ATM cells, wherein associating the sequence identifier with each one of said ATM cells includes identifying when a particular sequence identifier results in a header portion bit value that corresponds to a reference bit value designating a reference function and preventing the particular sequence identifier from being associated with any one of said ATM cells;

specifying a cell capacity of a first transmitter queue and a cell capacity of a second transmitter queue, wherein the cell capacity of the first transmitter queue and the cell capacity of the second transmitter queue are based on a reference data transmission rate of the first one of the plurality of IM communication links and to a reference data transmission rate of the second one of the plurality of IM communication links, respectively;

holding a first portion and a second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, wherein the first transmitter queue and the second transmitter queue are associated with a first one and a second one, respectively, of a plurality of IM communication links; and

sequentially forwarding said sequence-identified ATM cells from each said queue over said associated one of the plurality of IM communication links, wherein the first one of the plurality of IM communication links has a data transmission rate disparate in at least one data transmission direction with respect to a data transmission rate of the second one of the plurality of IM communication links; and

the second data processor program being capable of enabling the second data processor to facilitate:

receiving at least a portion of said sequence-identified ATM cells;

determining a receiver queue position associated with each one of said sequence-identified ATM cells in response to receiving each one of said sequence-identified ATM cells; and

forwarding an aligned stream of inversely multiplexed ATM cells from the receiver across a destination endpoint logical communication link.

63. An inverse multiplexing capable communication system, comprising:

a first communication apparatus including a first transmitter queue and a second transmitter queue, wherein the first communication apparatus is capable of being coupled between an originating endpoint logical communication link and a plurality of IM communication links; and

a first data processor program processable by a first data processor of the first communication apparatus;

the first data processor program being capable of enabling the first communication apparatus to facilitate:

receiving a stream of sequentially aligned ATM cells via the originating end point logical communication link;

associating a sequence identifier with each one of said ATM cells for creating sequence-identified ATM cells;

holding a first portion and a second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, wherein the first transmitter queue and the second transmitter queue are associated with a first one and a second one, respectively, of the plurality of IM communication links; and

sequentially forwarding said sequence-identified ATM cells from each said queue over said associated one of the plurality of IM communication links, wherein the first one of the plurality of IM communication links has a data transmission rate disparate in at least one data transmission direction with respect to a data transmission rate of the second one of the plurality of IM communication links.

64. The inverse multiplexing capable communication system of claim 64 wherein:

the first communication apparatus further includes a transmitter queue selector;

enabling the first communication apparatus to facilitate receiving the stream of sequentially aligned ATM cells includes enabling the first communication apparatus to facilitate receiving the stream of sequentially aligned ATM cells at the transmitter queue selector; and

the transmitter queue selector is capable of enabling the first portion and the second portion of said sequence-identified ATM cells to be added to the first transmitter queue and the second transmitter queue, respectively.

65. The inverse multiplexing capable communication system of claim 64 wherein enabling the first communication apparatus to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first communication apparatus to facilitate determining a sequence code for each one of said ATM cells and to facilitate inserting the sequence code for each one of said ATM cells into an information payload portion of a corresponding one of said ATM cells.

66. The inverse multiplexing capable communication system of claim 64 wherein enabling the first communication apparatus to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first communication apparatus to facilitate determining a sequence code for each one of said ATM cells and to facilitate inserting the sequence code for each one of said ATM cells into a header portion of a corresponding one of said ATM cells.

67. The inverse multiplexing capable communication system of claim 66 wherein enabling the first communication apparatus to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first communication apparatus to facilitate identifying at least one of unused addressing bits and unused address space within the header portion of the corresponding one of said ATM cells and to facilitate redefining said at least one of unused addressing bits and unused address space to designate the sequence identifier.

68. The inverse multiplexing capable communication system of claim 66 wherein enabling the first communication apparatus to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first communication apparatus to facilitate identifying when a particular sequence identifier results in a header portion bit value that corresponds to a reference bit value designating a reference function.

69. The inverse multiplexing capable communication system of claim 68 wherein the first data processor program is further capable of enabling the first communication apparatus to facilitate:

preventing the particular sequence identifier from being associated with any one of said ATM cells.

70. The inverse multiplexing capable communication system of claim 63 wherein:

the first communication apparatus further includes a transmitter selector; and

enabling the first communication apparatus to facilitate associating the sequence identifier with each one of said ATM cells includes enabling the first communication apparatus to facilitate determining the sequence identifier for each one of said ATM cells in response to each one of said ATM cells arriving at the transmitter queue selector.

71. The inverse multiplexing capable communication system of claim 63 wherein the first data processor program is further capable of enabling the first communication apparatus to facilitate:

specifying a cell capacity of the first transmitter queue and a cell capacity of the second transmitter queue, wherein the cell capacity of the first transmitter queue and the cell capacity of the second transmitter queue are based on a reference data transmission rate of the first one of the plurality of IM communication links and to a reference data transmission rate of the second one of the plurality of IM communication links, respectively.

72. The inverse multiplexing capable communication system of claim 71 wherein:

the cell capacity of the first queue and the cell capacity of the second queue are different; and

an approximately common time period is required for transmitting a number of cells equal to the cell capacity of the first queue and a number of cells equal to the cell capacity of the second queue across the first one of the plurality of IM communication links and the second one of the plurality of IM communication links, respectively.

73. The inverse multiplexing capable communication system of claim 72 wherein enabling the first communication apparatus to facilitate holding the first portion and the second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, includes enabling the first communication apparatus to facilitate directing a next one of the sequence-identified ATM cells to a most empty one of the first transmitter queue and the second transmitter queue.

74. The inverse multiplexing capable communication system of claim 73 wherein enabling the first communication apparatus to facilitate holding the first portion and the second portion of said sequence-identified ATM cells in the

first transmitter queue and the second transmitter queue, respectively, includes enabling the first communication apparatus to facilitate directing a previous one of the sequence-identified ATM cells to one of the first transmitter queue and the second transmitter queue and directing the next one of the sequence-identified ATM cells to a next transmitter queue with respect to said one of the first transmitter queue and the second transmitter queue.

75. The inverse multiplexing capable communication system of claim 63, further comprising:

a second communication apparatus capable of being coupled between a destination endpoint logical communication link and the plurality of IM communication links; and

a second data processor program processable by a second data processor of the second communication apparatus;

the second data processor program being capable of enabling the second communication apparatus to facilitate:

receiving at least a portion of said sequence-identified ATM cells; and

forwarding an aligned stream of inversely multiplexed ATM cells from the second communication apparatus across the destination endpoint logical communication link.

76. The inverse multiplexing capable communication system of claim 75 wherein:

the second communication apparatus further includes a receiver queue; and

enabling the second communication apparatus to facilitate receiving said sequence-identified ATM cells includes enabling the second communication apparatus to facilitate holding at least a portion of said sequence-identified ATM cells in the receiver queue.

77. The inverse multiplexing capable communication system of claim 76 wherein the second communication apparatus program is further capable of enabling the second communication apparatus to facilitate:

determining a receiver queue position associated with each one of said sequence-identified ATM cells in response to receiving each one of said sequence-identified ATM cells.

78. The inverse multiplexing capable communication system of claim 76 wherein enabling the data processor to facilitate forwarding the aligned stream of inversely multiplexed ATM cells includes enabling the second communication apparatus to facilitate sequentially retrieving said sequence-identified ATM cells from the receiver queue.

79. The inverse multiplexing capable communication system of claim 78 wherein enabling the second communication apparatus to facilitate sequentially retrieving said sequence-identified ATM cells includes enabling the second communication apparatus to facilitate identifying a next one of said sequence-identified ATM cells to forward.

80. The inverse multiplexing capable communication system of claim 78 wherein enabling the second communication apparatus to facilitate identifying the next one of the sequence-identified ATM cells includes enabling the second communication apparatus to facilitate determining the sequence identifier associated with the next one of the sequence-identified ATM cell.

81. The inverse multiplexing capable communication system of claim 77 wherein enabling the second communication apparatus to facilitate sequentially retrieving said sequence-identified ATM cells includes enabling the second communication apparatus to facilitate:

delaying forwarding of a received one of said sequence-identified ATM cells being held in the receiver queue in response to determining that the next one of said sequence-identified ATM cells is missing from an expected position in the receiver queue;

discontinuing attempts to retrieve the next one of said sequence-identified ATM cells after a prescribed time period elapses while the next one of said sequence-identified ATM cells remains missing from the expected positioning the receiver queue; and

retrieving the next one of said sequence-identified ATM cells before the prescribed time period elapses in response to determining that the next one of said sequence-identified ATM cells is located in the expected position in the receiver queue after having initially determined that the next one of said sequence-identified ATM cells was missing from an expected position in the receiver queue.

82. The inverse multiplexing capable communication system of claim 81 wherein enabling the second communication apparatus to facilitate forwarding the aligned stream of inversely multiplexed ATM cells from the receiver includes enabling the second communication apparatus to facilitate:

forwarding the received one of said sequence-identified ATM cells after the prescribed time period elapses in response to the next one of said sequence-identified ATM cells remains missing from the expected positioning the receiver queue after the prescribed time period elapses; and

forwarding the next one of said sequence-identified ATM cells in response to retrieving the next one of said sequence-identified ATM cells before the prescribed time period elapses and after having initially determined that the next one of said sequence-identified ATM cells was missing from an expected position in the receiver queue.

83. An inverse multiplexing capable communication system, comprising:

a first communication apparatus including a first transmitter queue and a second transmitter queue, wherein the first communication apparatus is capable of being coupled between an originating endpoint logical communication link and a plurality of IM communication links;

a second communication apparatus capable of being coupled between a destination endpoint logical communication link and the plurality of IM communication links;

a first data processor program processable by the first communication apparatus;

a second data processor program processable by the second communication apparatus;

the first data processor program being capable of enabling the first communication apparatus to facilitate:

receiving a stream of sequentially aligned ATM cells via an originating end point logical communication link, wherein the stream of sequentially aligned ATM cells is received at a transmitter queue selector and the transmitter queue selector is capable of enabling the first portion and the second portion of said sequence-identified ATM cells to be added to the first transmitter queue and the second transmitter queue, respectively;

associating a sequence identifier with each one of said ATM cells for creating sequence-identified ATM cells, wherein associating the sequence identifier with each one of said ATM cells includes identifying when a particular sequence identifier results in a header portion bit value that corresponds to a reference bit value designating a reference function and preventing the particular sequence identifier from being associated with any one of said ATM cells;

specifying a cell capacity of a first transmitter queue and a cell capacity of a second transmitter queue, wherein the cell capacity of the first transmitter queue and the cell capacity of the second transmitter queue are based on a reference data transmission rate of the first one of the plurality of IM communication links and to a reference data transmission rate of the second one of the plurality of IM communication links, respectively;

holding a first portion and a second portion of said sequence-identified ATM cells in the first transmitter queue and the second transmitter queue, respectively, wherein the first transmitter queue and the second transmitter queue are associated with a first one and a second one, respectively, of the plurality of IM communication links; and

sequentially forwarding said sequence-identified ATM cells from each said queue over said associated one of the plurality of IM communication links, wherein the first one of the plurality of IM communication links has a data transmission rate disparate in at least one data transmission direction with respect to a data transmission rate of the second one of the plurality of IM communication links; and

the second data processor program being capable of enabling the second communication apparatus to facilitate:

receiving at least a portion of said sequence-identified ATM cells;

determining a receiver queue position associated with each one of said sequence-identified ATM cells in response to receiving each one of said sequence-identified ATM cells; and

forwarding an aligned stream of inversely multiplexed ATM cells from the receiver across the destination endpoint logical communication link.

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